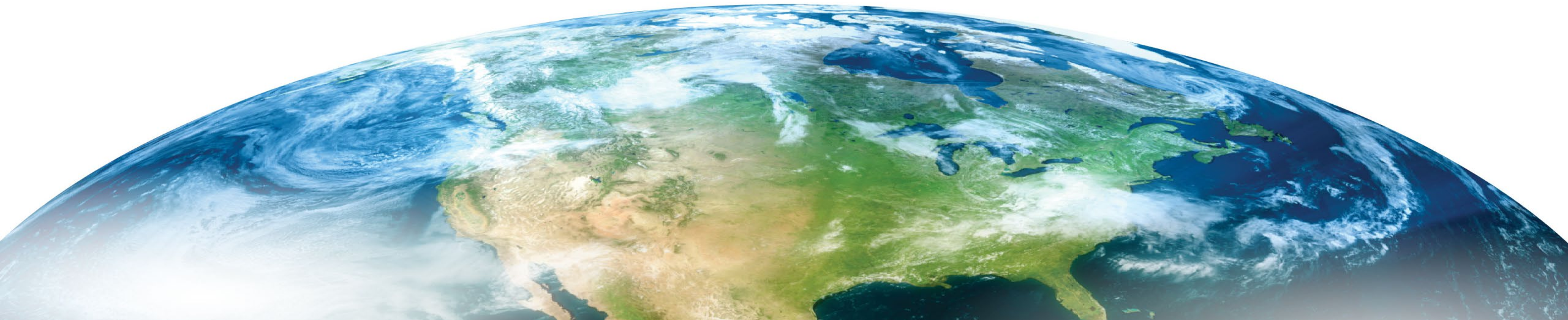




Unmanned Aircraft Systems (UAS) Traffic Management (UTM) Pilot Program (UPP) Phase 2

Industry Workshop

December 2019



Agenda

| Meeting Topics | Name | Time (PST) |
|---------------------------------------|---|--------------------|
| Registration | All | 12:30 pm – 1:00 pm |
| Welcome & Opening Remarks | NASA Parimal Kopardekar | 1:00 pm – 1:15 pm |
| UTM Framework | NASA Joseph Rios | 1:15 pm – 1:30 pm |
| Overview of UTM Pilot Program Phase 2 | FAA Praveen Raju | 1:30 pm – 1:45 pm |
| Use Cases & Scenarios - Part I | FAA / LS Technologies Praveen Raju / Tayo Ladeinde | 1:45 pm – 2:15 pm |
| <i>Break</i> | | 2:15 pm – 2:30 pm |
| Use Cases & Scenarios - Part II | FAA / LS Technologies Praveen Raju / Tayo Ladeinde | 2:30 pm – 3:15 pm |
| Next Steps | FAA Praveen Raju | 3:15 pm – 3:30 pm |
| Questions & Answers | All | 3:30 pm – 3:55 pm |
| Wrap Up | NASA Parimal Kopardekar | 3:55 pm – 4:00 pm |
| USS / UAS Operator Collaborative Hour | NASA Parimal Kopardekar / Joseph Rios | 4:00 pm – 5:00 pm |

Welcome & Opening Remarks



UTM Framework



What is UAS Traffic Management?



UTM is an “air traffic management” ecosystem for small UAS in low altitude airspace

UTM utilizes industry's ability to supply services under FAA's regulatory authority where these services do not exist.

UTM development will ultimately identify services, roles/responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements to enable the management of low-altitude UAS operations.

Transparency

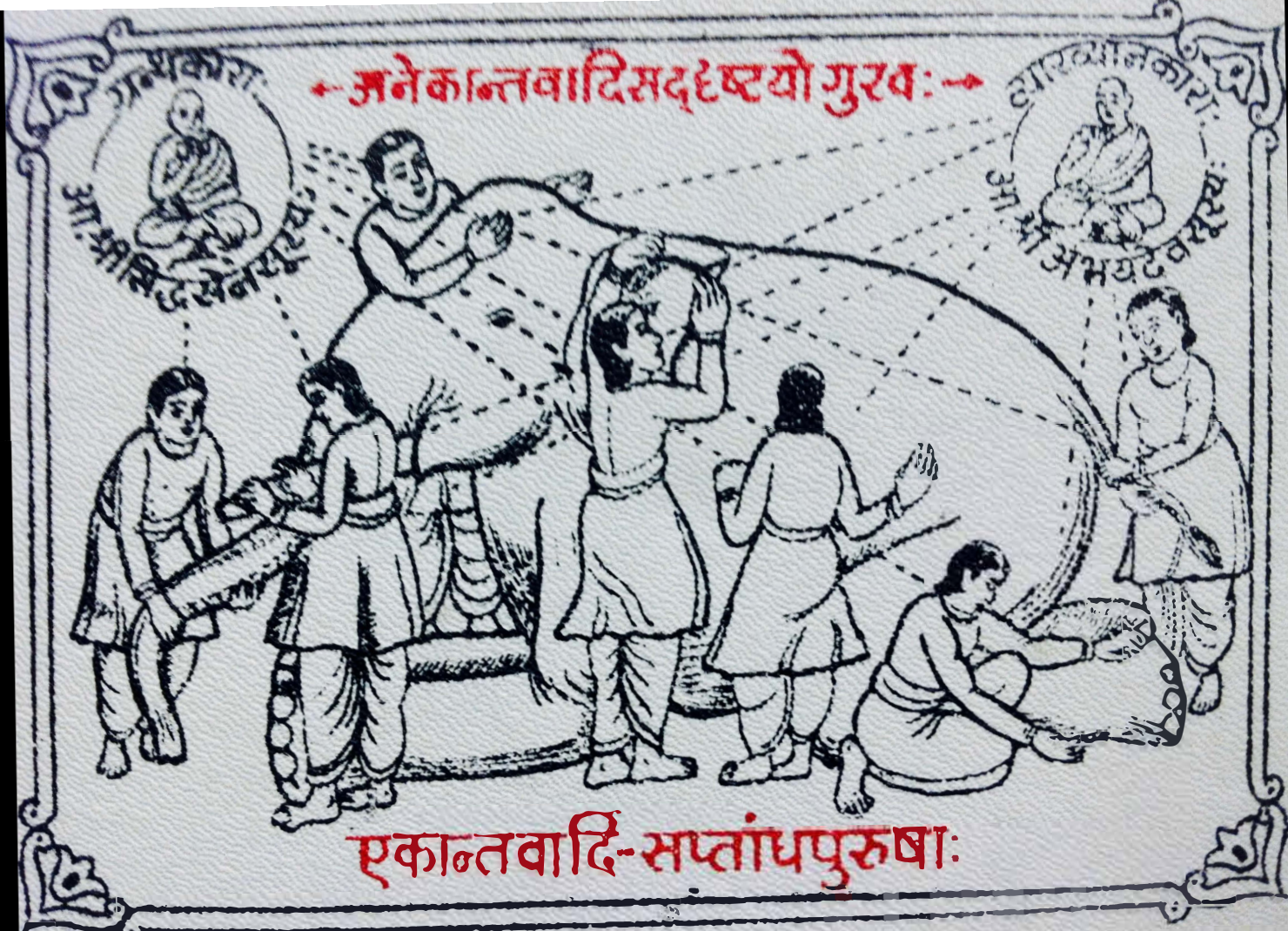
Security

Safety

Commerce

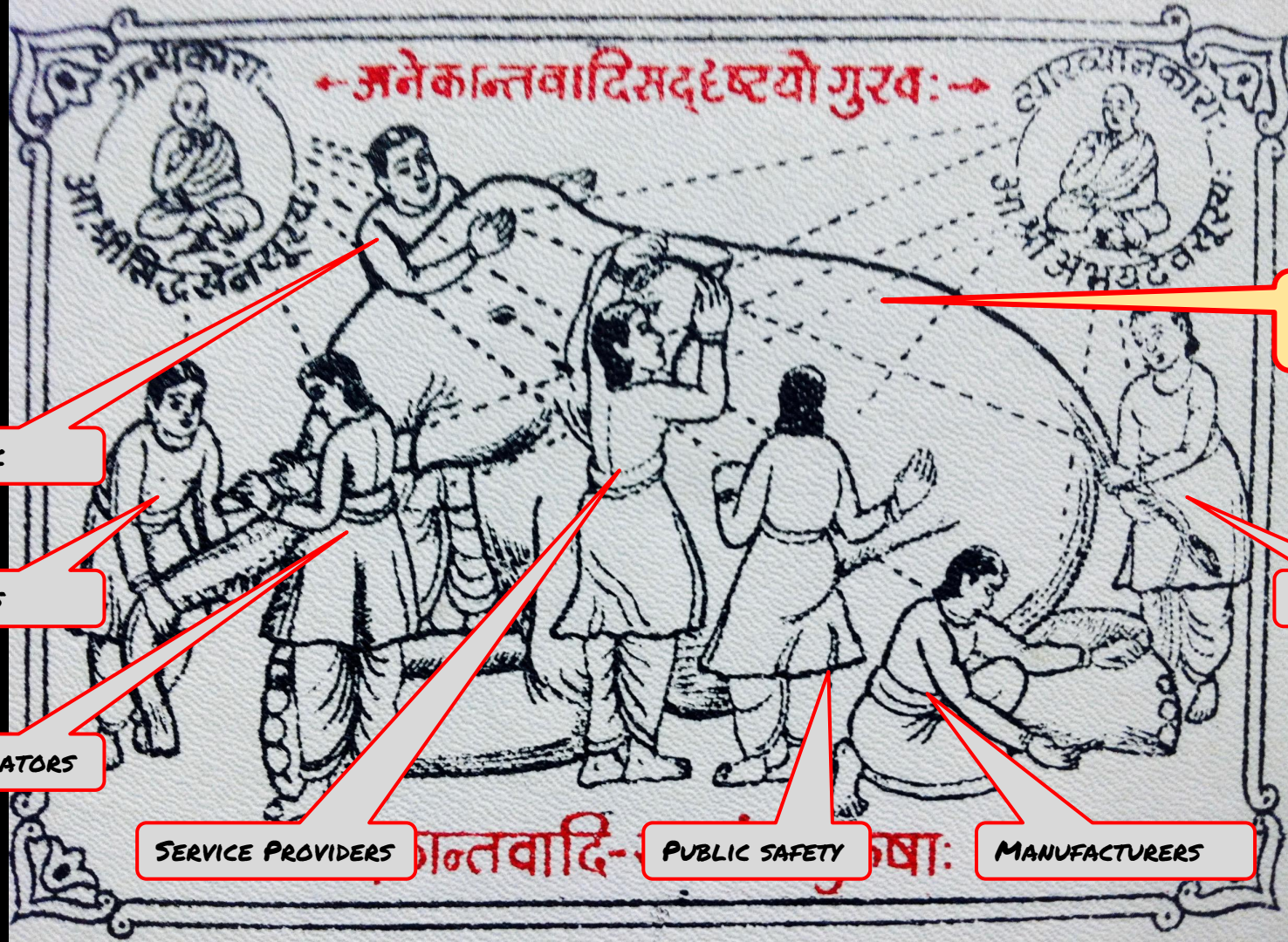
Scalability





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PUBLIC

UTM

PILOTS

OPERATORS

REGULATORS

SERVICE PROVIDERS

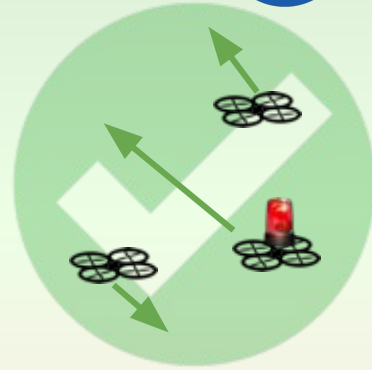
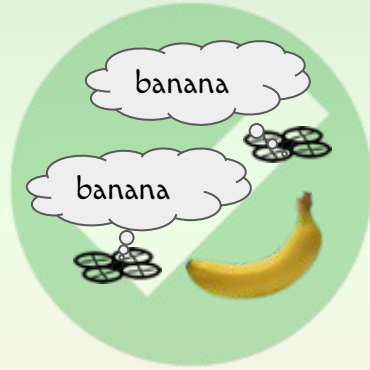
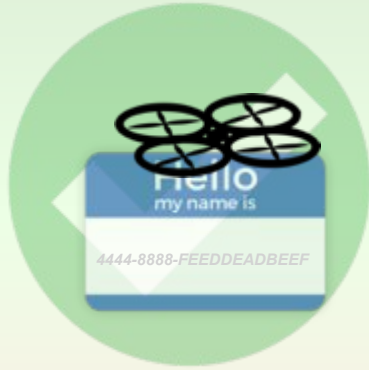
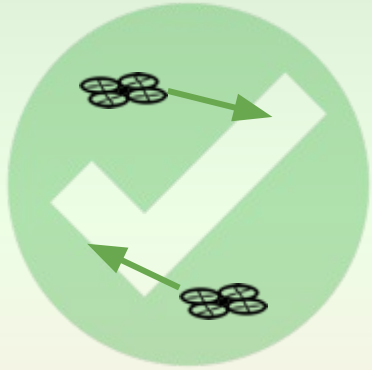
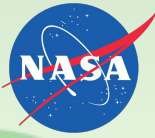
PUBLIC SAFETY

MANUFACTURERS

अनेकान्तवादि-

गुणाः

UTM core operating principles



Technical Capability Levels (TCL)



Risk-based development and test approach



TCL 1

Remote Population

Low Traffic Density

Rural Applications

Multiple VLOS Operations

Notification-based
Operations

TCL 2

Sparse Population

Low-Mod Traffic Density

Rural / Industrial Applications

Multiple BVLOS Operations

Tracking and Operational
Procedures

TCL 3

Moderate Population

Moderate Traffic Density

Suburban Applications

Mixed Operations

Vehicle to Vehicle Communication
Public Safety Operations

TCL 4

Dense Population

High Traffic Density

Urban Applications

Dense BVLOS Operations

Large Scale Contingency
Management

Technical Capability Levels (TCL)



Risk-based development and test approach



TCL 1

Remote Population
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Rural Applications
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Notification-based
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Moderate Traffic Density
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Public Safety Operations

TCL 4

Dense Population
High Traffic Density
Urban Applications
Dense BVLOS Operations
Large Scale Contingency
Management

First UTM HWITL Ground Test,
April 2015



First UTM Flight Test, May 2015



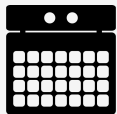
TCL1, Crows Landing, Summer 2015



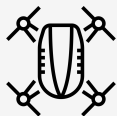
National Campaign



Demonstrated management of geographically diverse operations, 4 live vehicles from each test site flown simultaneously under UTM



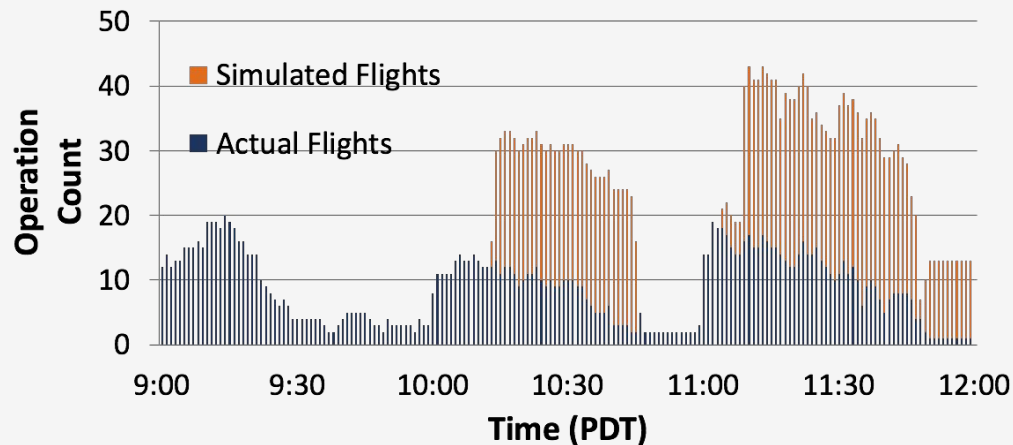
19 April 2016



24 live vehicles, 100+ live/sim ops under UTM in one hour

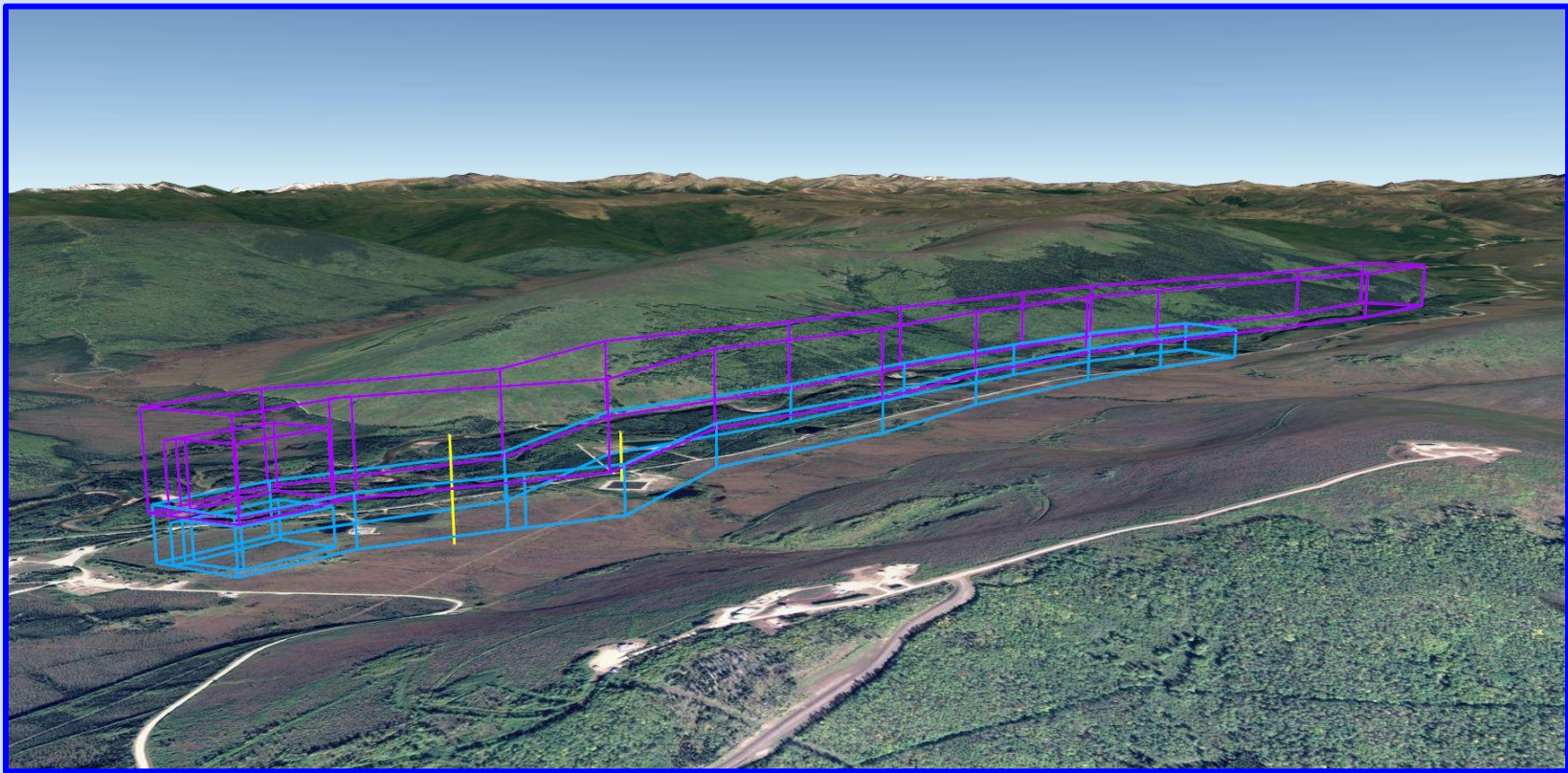


Showed REST API approach to data sharing is valid, opening path to many *-ilities

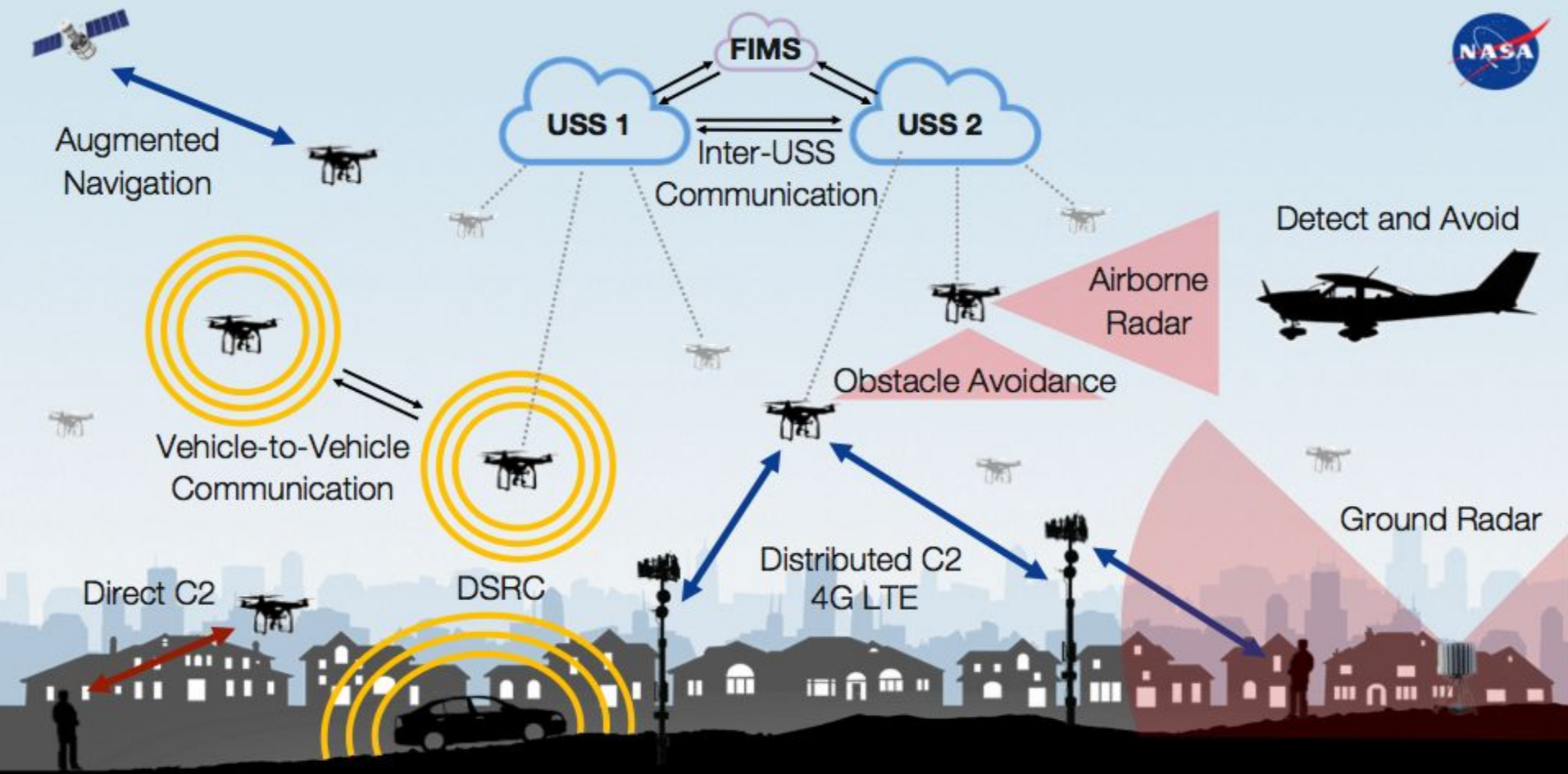




TCL2 Flight Testing
Oct 2016



National Campaign 2
Spring 2017



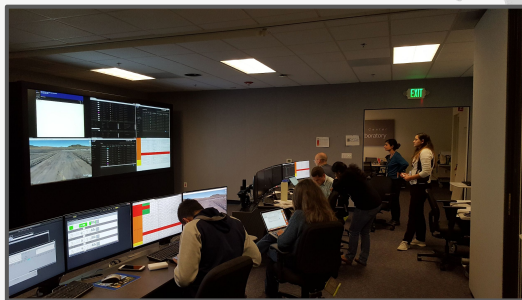


TCL 3
Flight
Testing





Reno test range



NASA UTM Command Center



Corpus Christi test range

TCL4

- Furthering the tools and concepts for urban operations
- Comm+Nav, Detect and Avoid, Large scale contingency management, etc.
- Flights May-Aug 2019

4 Small UAS
Over Downtown
Reno

NASA TCL4

18 June 2019



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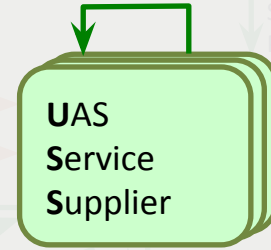


ASTM Specification forthcoming

USS share data for operations that are under their management. Data include intent, updates, requests, position reports, alerts, and other messages.

Conceptually designed to be highly automated, in early stages, humans are in the loop for more complex tasks.

Remote ID likely considered two separate, specialized USS functions (op support and op lookup)



NAS Data
Sources

National
Airspace
System

Flight
Information
Management
System

Color Key:

ANSP Function

Operator Function

Other Stakeholders

A key aspect of UPP testing.

Exercised in TCLs and UPP 1.0 to inform UPP 2.0 testing and ConOps development

NASA tech transfer of initial FIMS code to FAA. FAA looking at how it fits into the existing and future IT architecture

Testing directly informs conceptual conversations

USS Discovery process highlighted by NASA as key architectural concern. Posed initial solution in TCL2 timeframe. Industry developed improved solution tested in TCL3 and 4. Input from NASA testing and industry collaboration moved discovery to an open source project under the Linux Foundation (DSS).

Authentication and authorization paper published by NASA with close discussion with the FAA. Paper summarizes auth architecture through TCL4 and somewhat beyond.

Registration issues are a key component of UPP testing.

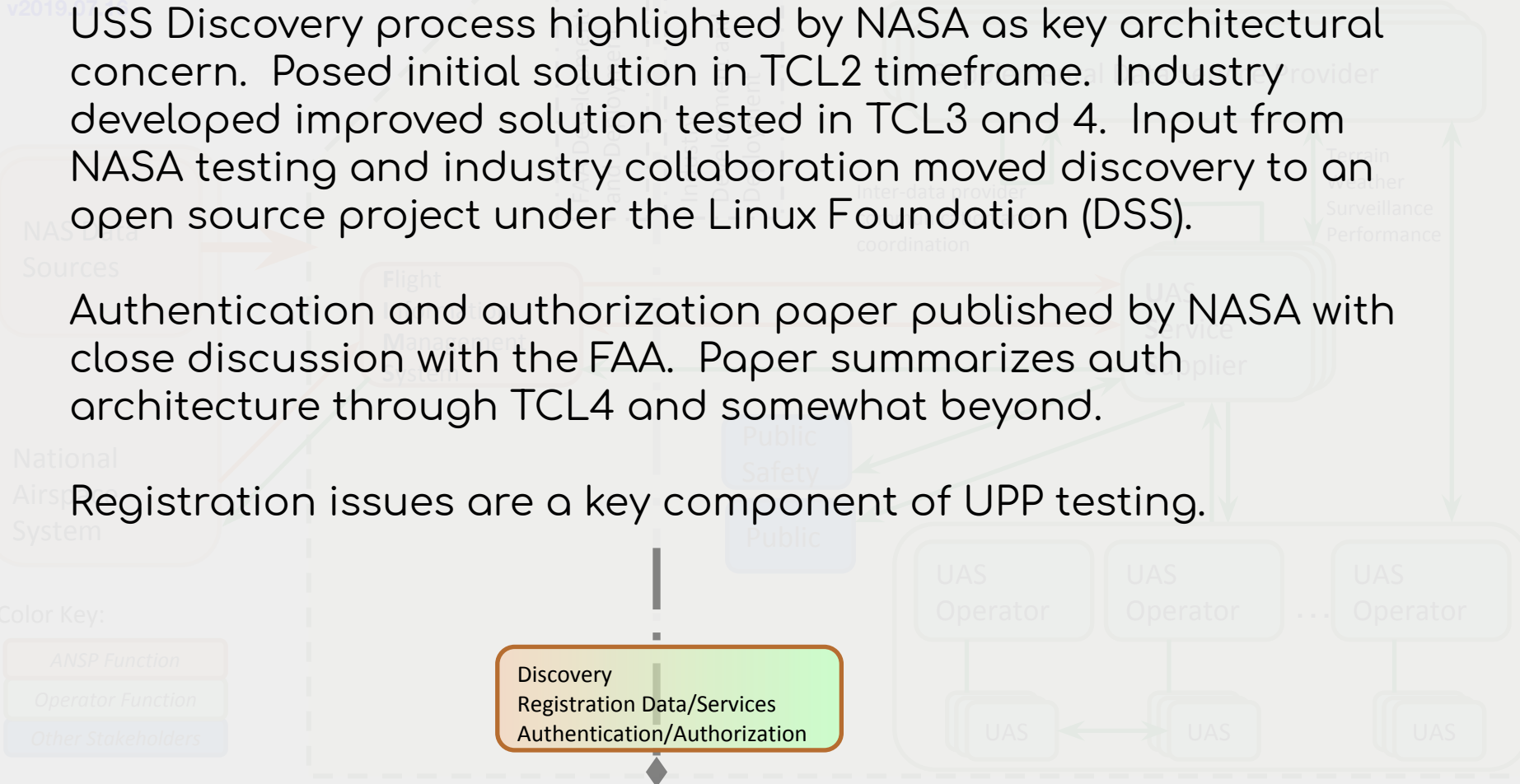
Color Key:

ANSP Function

Operator Function

Other Stakeholders

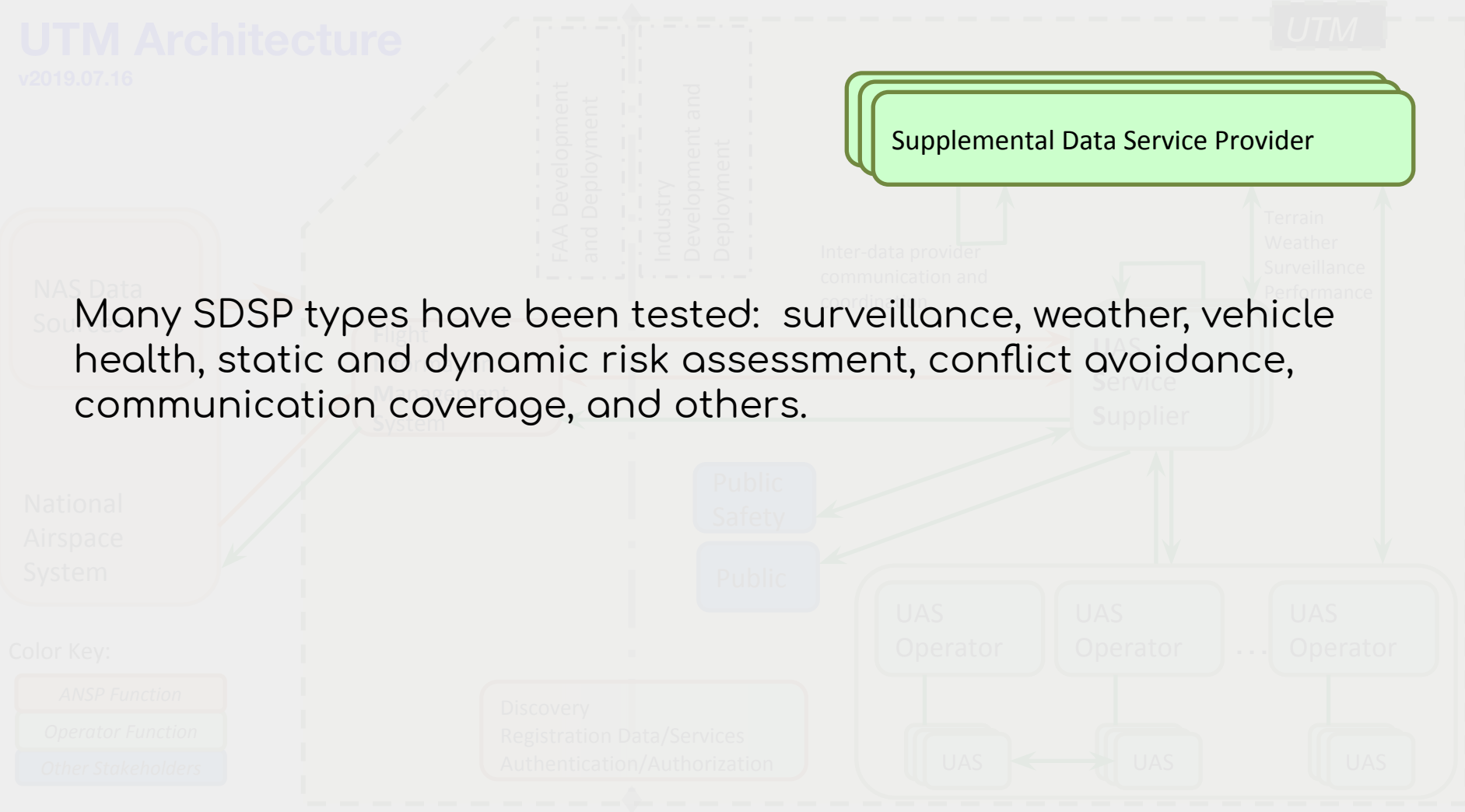
Discovery
Registration Data/Services
Authentication/Authorization



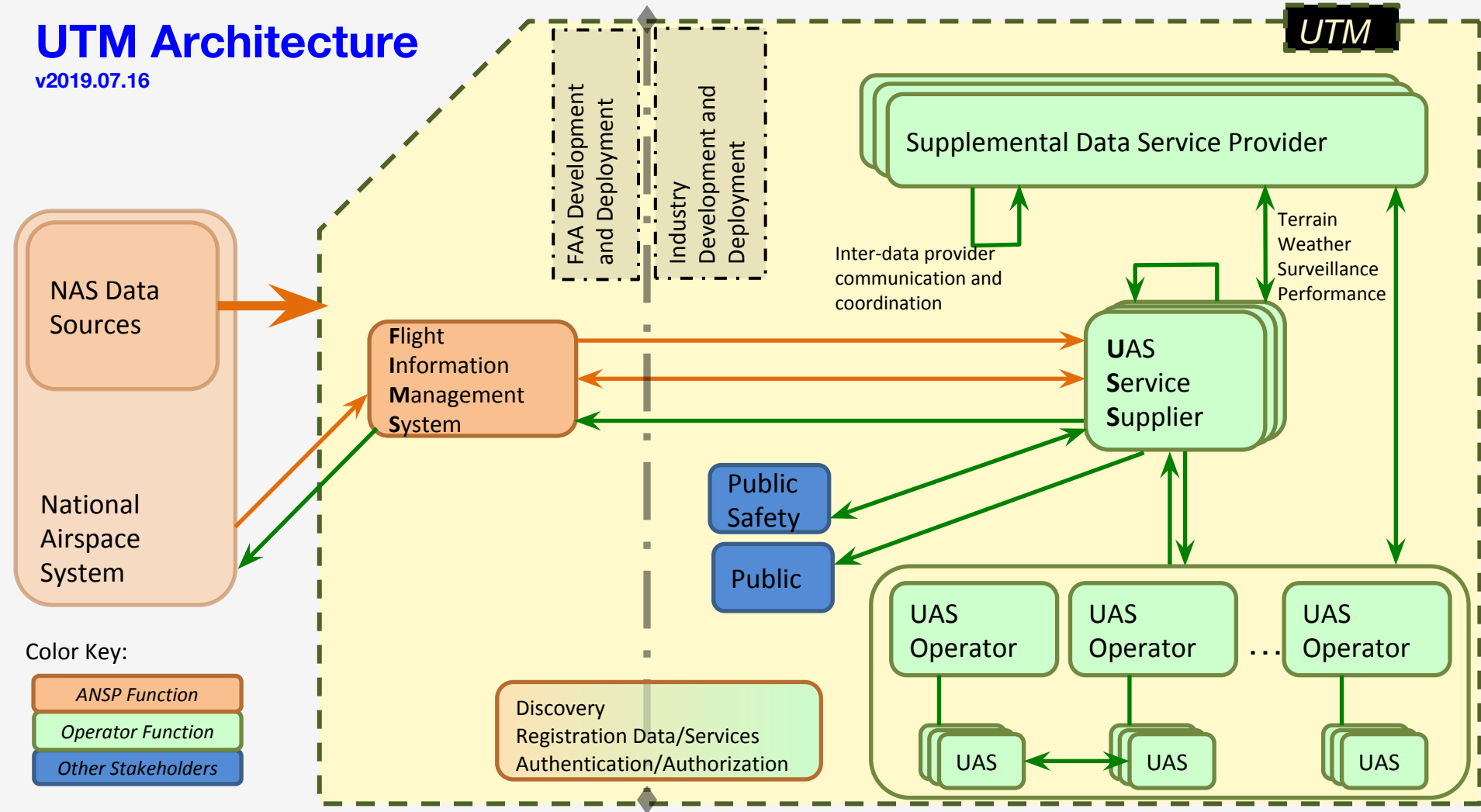
UTM Architecture

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Many SDSP types have been tested: surveillance, weather, vehicle health, static and dynamic risk assessment, conflict avoidance, communication coverage, and others.



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FAA

- Subject matter expertise
- ConOps
- Information requirements
- Roles & responsibilities
- Interoperability needs

+

NASA

- Information arch and data exchange def.
- Research platform development
- ConOps
- Lead industry engagement
- Flight testing
- Performance requirements
- Inform standards

+

Industry

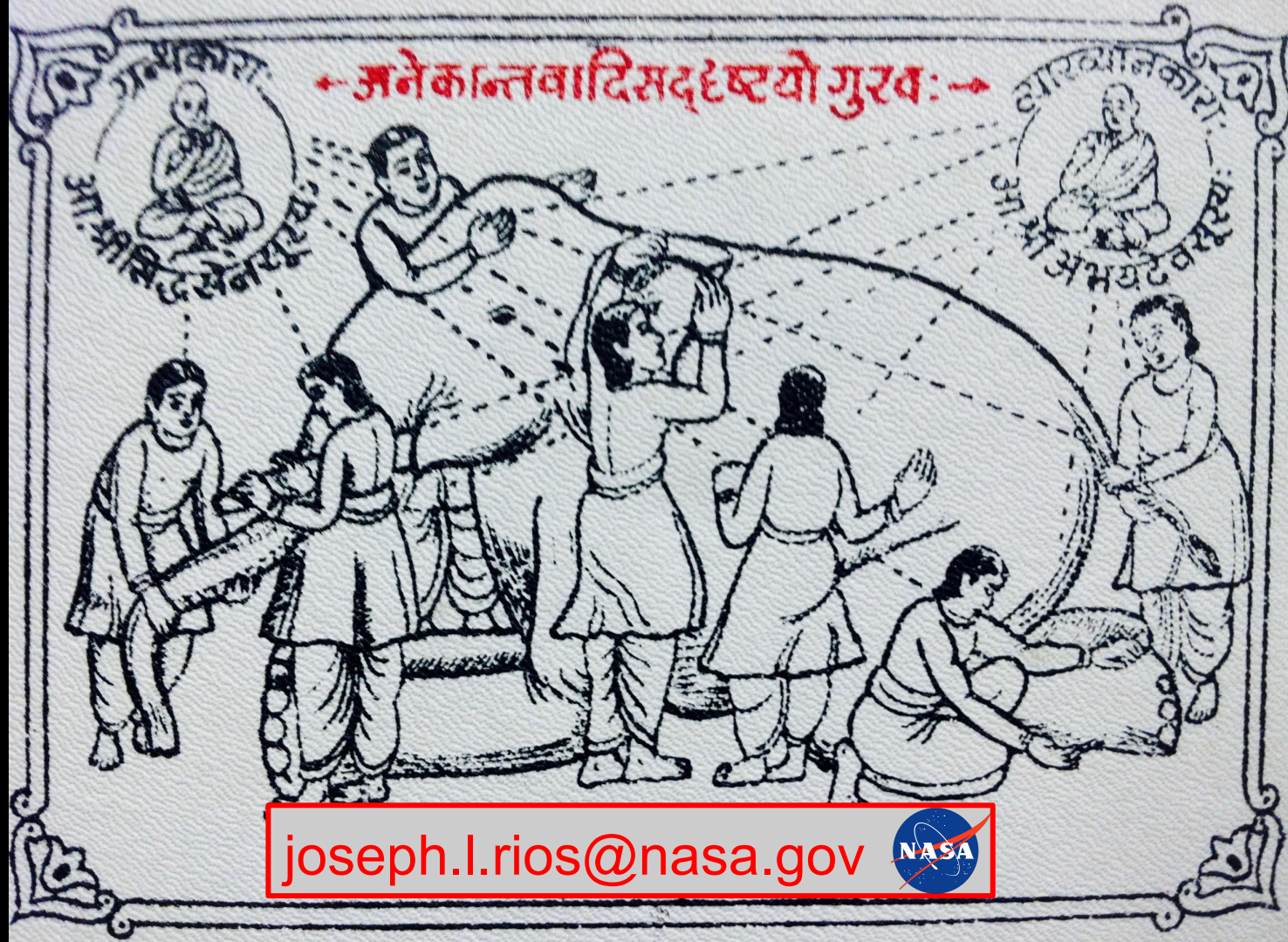
- Use cases
- Operational needs
- Technology readiness
- ConOps Validation
- Flight test participation
- Additional data services
- Liaison to international aviation authorities

Philosophy

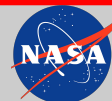
From UTM's inception, collaboration has been a priority.

Open RFI process for partners. Develop into Space Act Agreements if moving to testing with us.

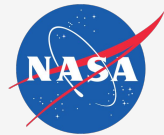
Regular engagement with FAA via Research Transition Team



joseph.l.rios@nasa.gov



Bibliography



Images

- Airplane by Will Sullivan from the [Noun Project](#)
- Industry by eragon from the Noun Project
- Drone by Alvaro Cabrera from the Noun Project
- romana klee, Anekantavada doctrine artwork, [source image](#), [Creative Commons Share-Alike License 2.0](#) , additional presentation elements added on top of image
- Test site images produced by NASA personnel
- All logos are property of their respective owners. Inclusion does not imply endorsement of any product by NASA. Inclusion does not imply endorsement of NASA's work by any other entity.

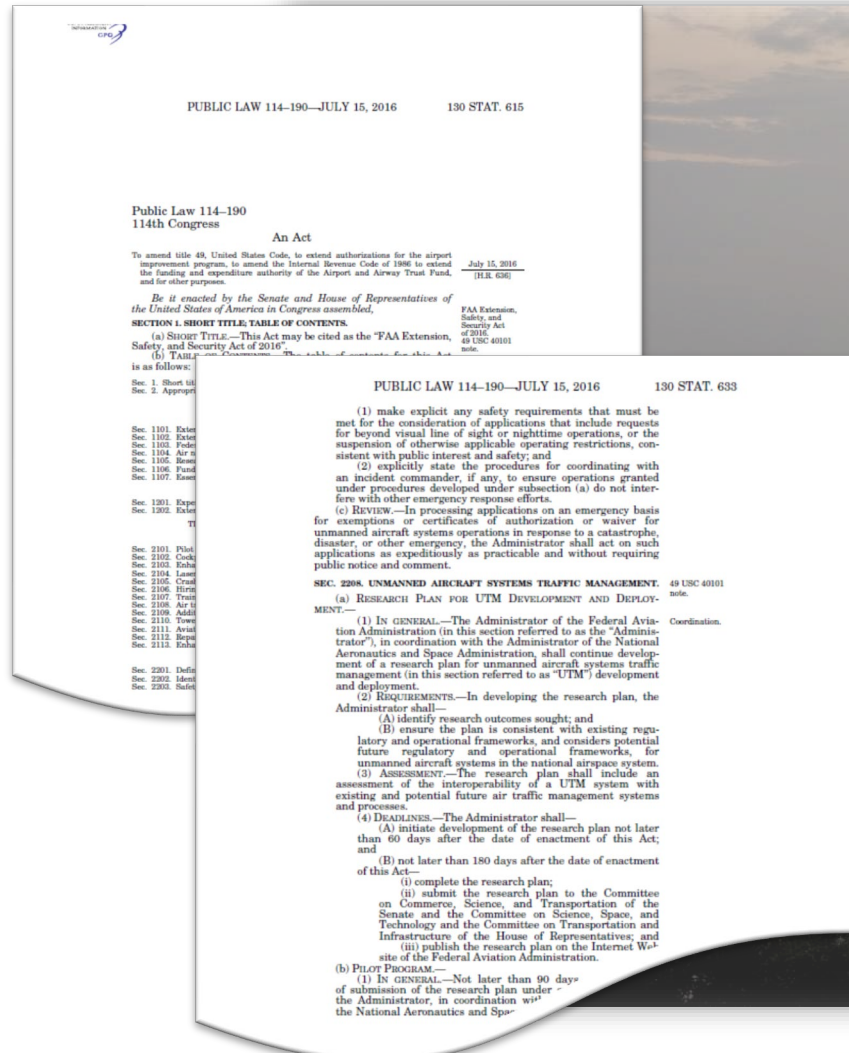
NASA UTM Docs

- <https://utm.arc.nasa.gov/documents.shtml>
- APIs: <https://github.com/nasa/utm-apis/tree/v4-draft>

Overview of UPP Phase 2



UPP Overview



UTM Pilot Program

FAA Reauthorization Act of 2018

- (a) In conjunction with completing the requirements of section 2208 of the FAA Extension, Safety, and Security Act of 2016 (49 U.S.C. 40101 note), subject to subsection
- (b) Completion of UTM System Pilot Program

UPP Phase 2 Objectives from the FAA 2018 Reauthorization

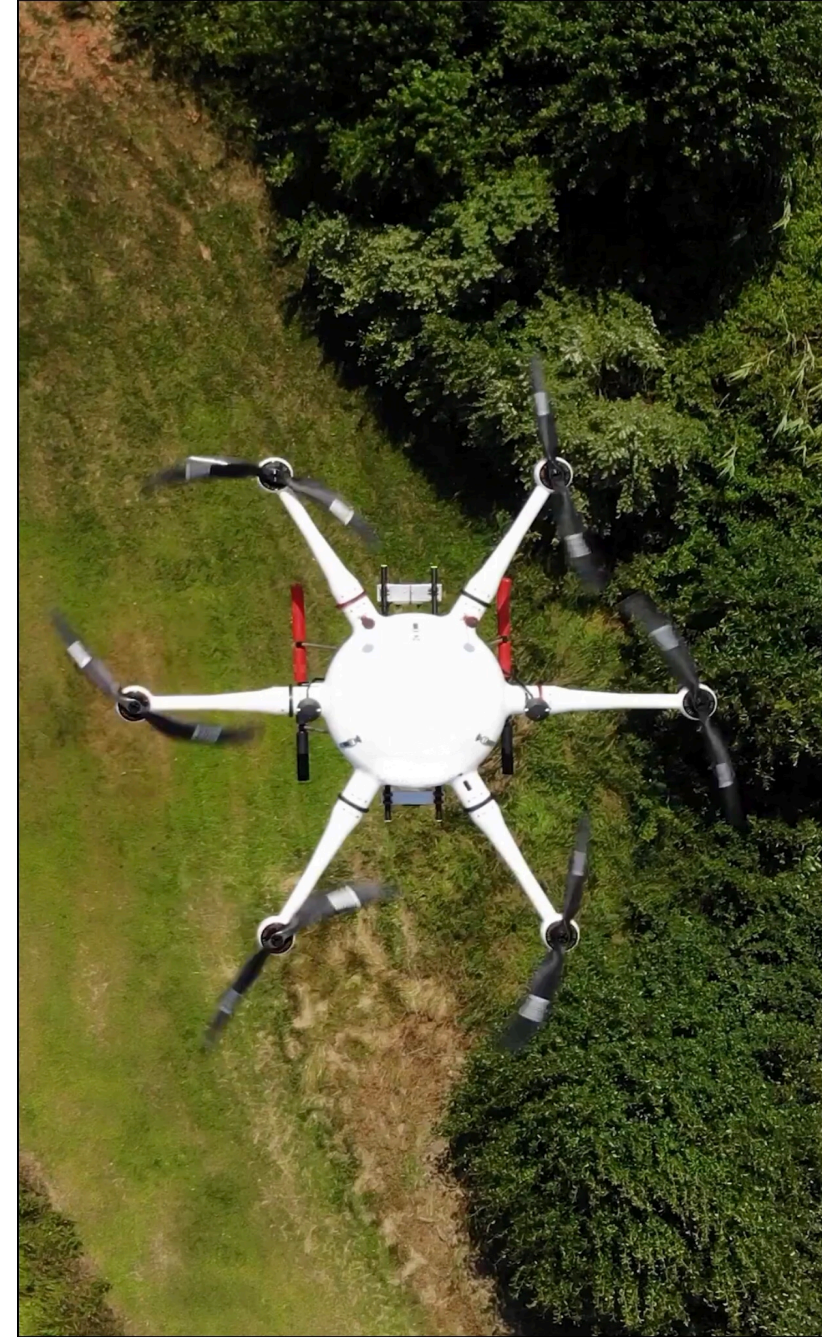


- In cooperation with the NASA and manned and unmanned aircraft industry stakeholders, allow testing of unmanned aircraft operations, of **increasing volumes and density**, in **airspace above test ranges**, as such term is defined in section 44801 of title 49, United States Code
- Conduct UTM testing, including those locations selected under the pilot program required in the October 25, 2017, Presidential Memorandum entitled, "**Unmanned Aircraft Systems Integration Pilot Program**" and described in 82 Federal Register 50301.
- Permit the testing of various **remote identification (ID) and tracking technologies** evaluated by the Unmanned Aircraft Systems Identification and Tracking Aviation Rulemaking Committee.

UPP Phase 2 Needs

FAA Vision:

- Execute a targeted technology demonstration showcasing the following capabilities and services supporting high-density operations:
 - Remote ID services
 - Public safety operations
 - UAS Volume Reservations (UVR) services
 - USS transmission of flight information to FAA due to off-nominal UTM event
- Support message security best practices for Authorization, Authentication, and Message Signing



Message Security Framework

Three components are used together to satisfy the security objectives

Certificate Authority (CA)

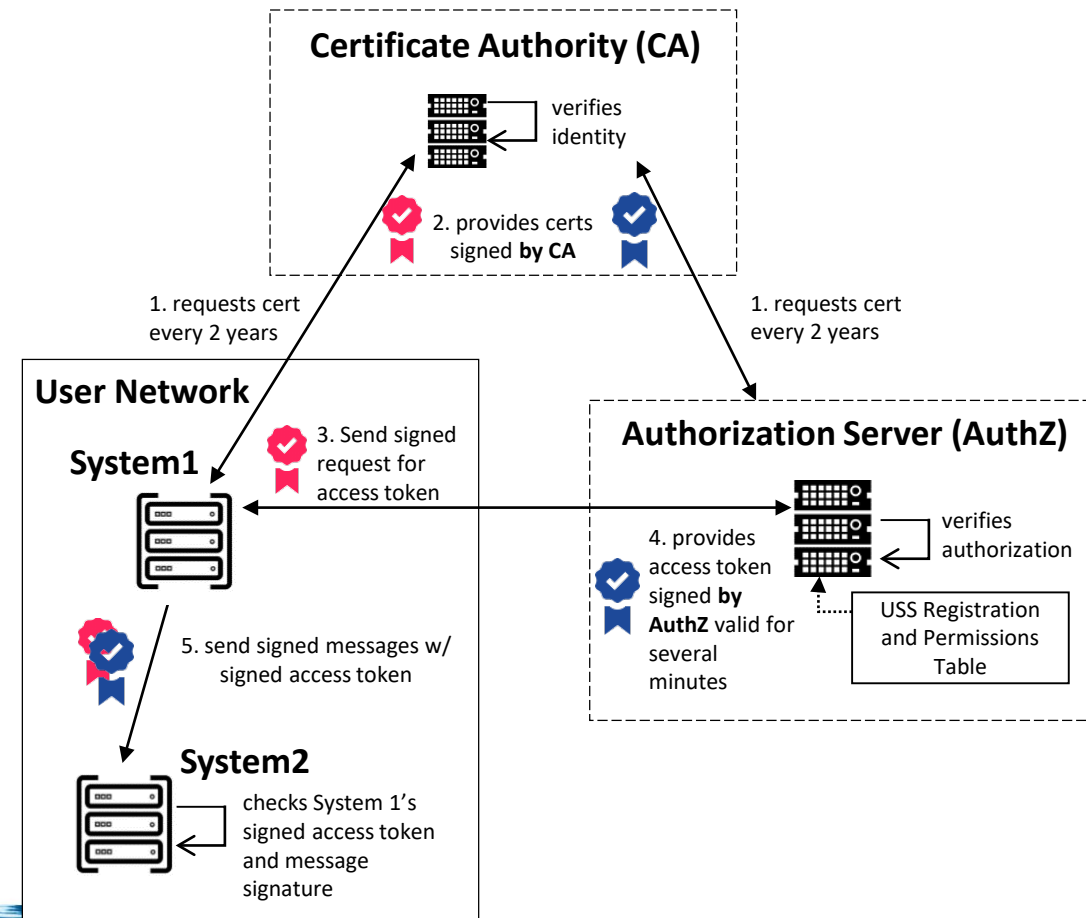
CAs manage digital certificates used to enable TLS connections and digital signatures. Certificates utilize cryptographic keys for authentication.

Authorization Server (AuthZ)

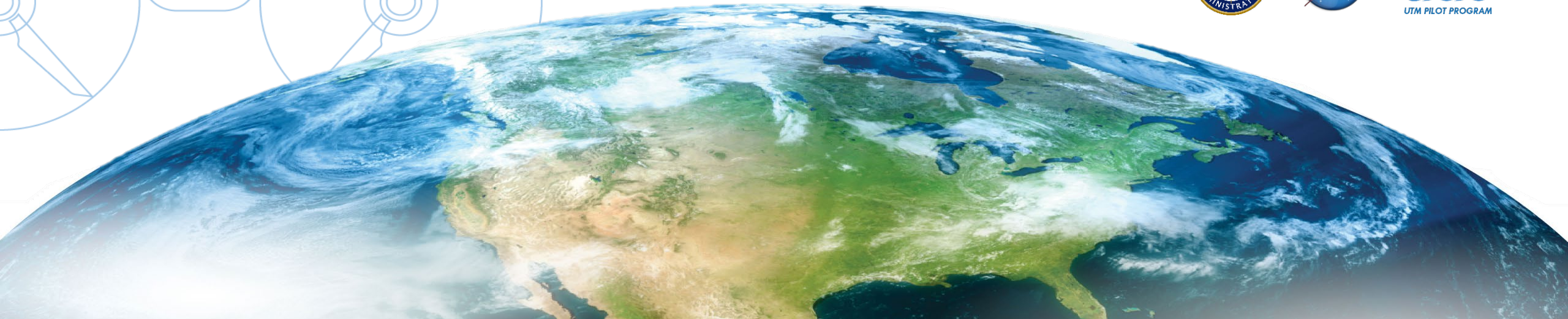
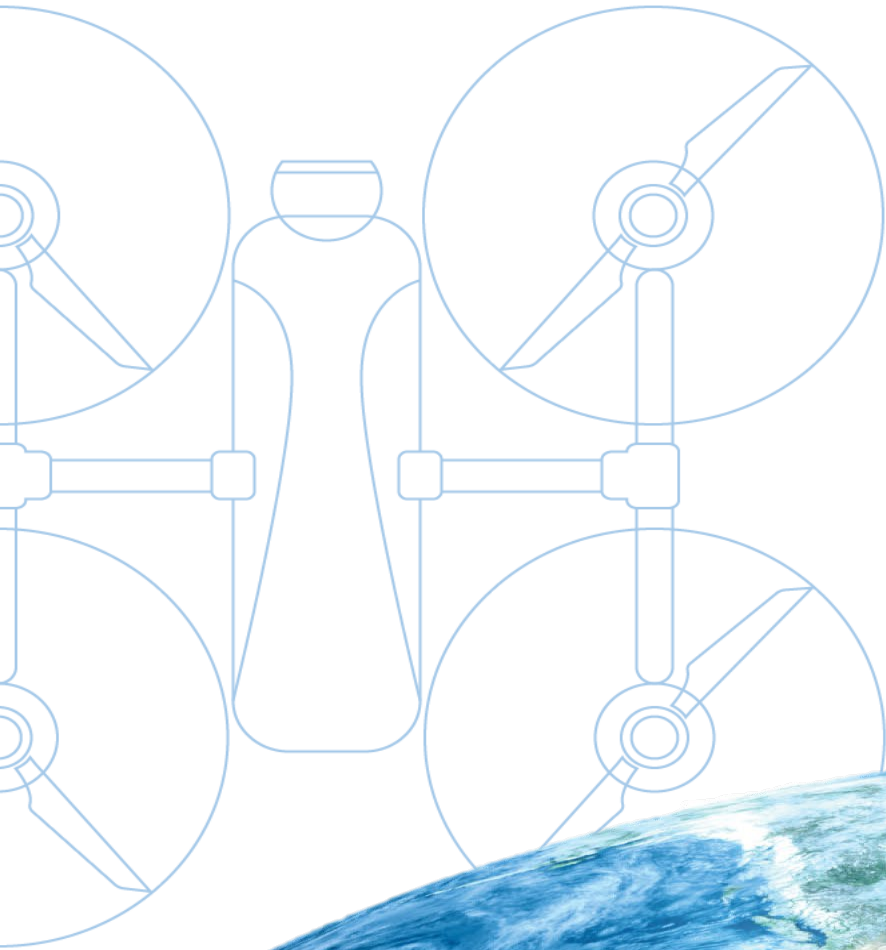
To perform UTM actions, users receive authorization (e.g., via access tokens) from the AuthZ, a centralized management system for access and permissions based on the OAuth 2.0 framework.

Message Signing

If users use certificates to produce digital signatures on their messages, these messages then have end-to-end non-repudiation and data integrity.

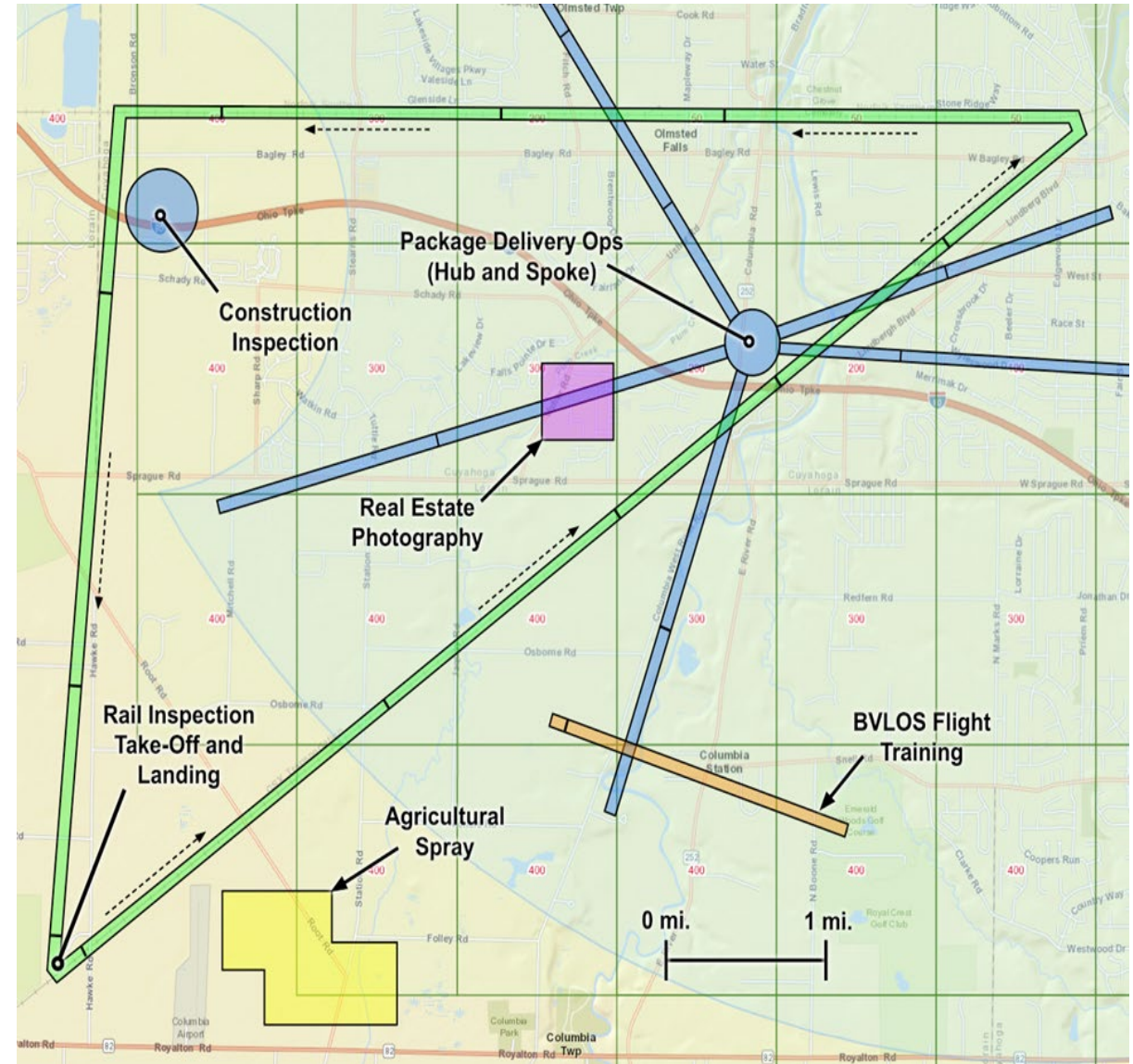


Use Cases & Scenarios



UPP Phase 2 Use Cases

1. Operation Planning by UAS Operators in High-Density Airspace
2. In-Flight Intent Changes by UAS Operators in High-Density Airspace
3. Public Safety UAS Operating within a UVR Volume
4. Public Identification of UAS via Remote ID Services
5. Federal and Public Safety Queries for Historical UTM Information



Use Case 1

Title: Operation Planning by UAS Operators in High-Density Airspace

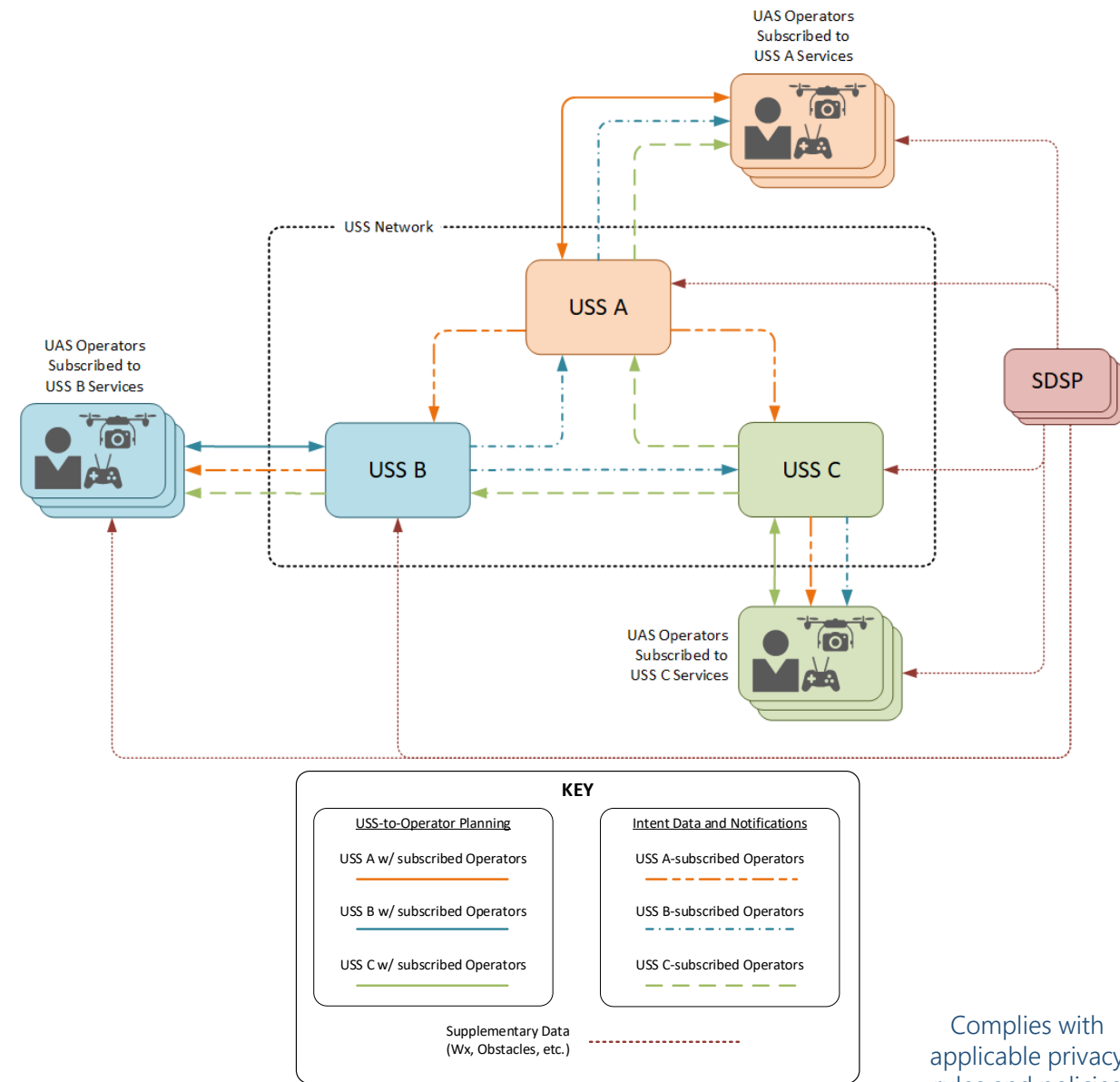
- Environment:
 - High-density airspace
 - Controlled and uncontrolled airspace
- This use case explores:
 - Operation planning
 - USS sharing operation intent with USS network
 - Automated or manual airspace authorizations
 - Strategic deconfliction by an operator without coordination
 - Coordinated strategic deconfliction between operators via USS services



Use Case 1

Title: Operation Planning by UAS Operators in High-Density Airspace

- Scenario:
 - Multiple VLOS and BVLOS operations occur throughout the day
 - Operators utilize planning services from USS A, B, and C, and share operation intent with the USS network
 - Using services from their USS, operators choose to strategically deconflict



Notional Diagram of Operation Planning and Intent Sharing with a USS Network

Use Case 2

Title: In-Flight Intent Changes by UAS Operators in High-Density Airspace

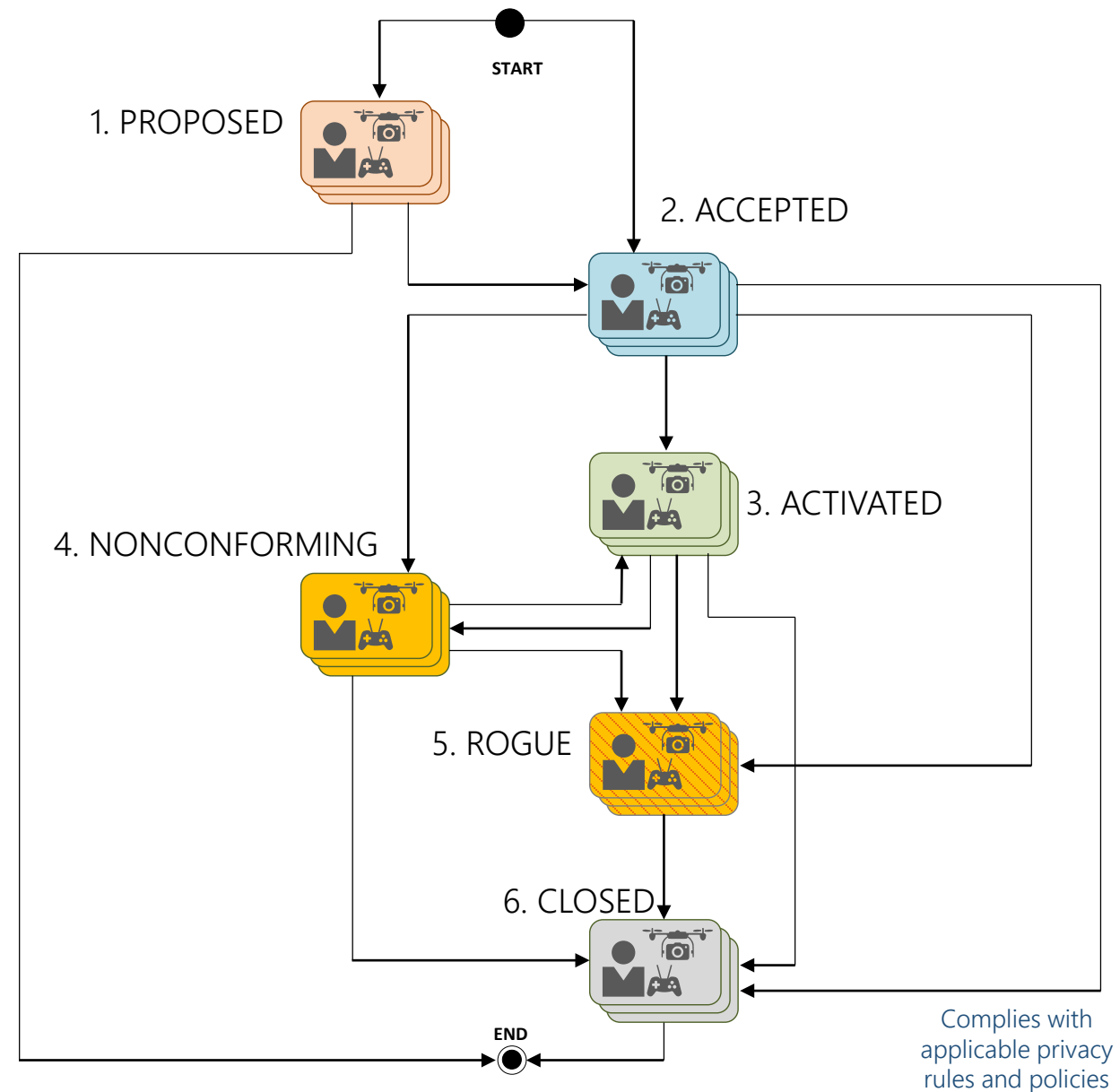
- Environment:
 - High-density airspace
 - Controlled and uncontrolled airspace
- This use case explores:
 - USS retrieval of relevant airspace activity data
 - Strategic deconfliction by an operator without coordination
 - Coordinated strategic deconfliction between operators via USS services
 - USS sharing operation state change with USS network
 - Supplemental Data Service Provider (SDSP) provision of relevant airspace activity data to operator
 - USS conformance monitoring of UAS to operation intent
 - USS performance monitoring of operator UAS platform



Use Case 2

Title: In-Flight Intent Changes by UAS Operators in High-Density Airspace

- Scenario:
 - UTM events result in a change to the operational state of the volume
 - Operators directly impacted by the airspace change receive notification from their USS and modify their operation intent as needed



Notional Diagram of Operation State Changes

Use Case 3

Title: Public Safety UAS Operating within a UVR Volume

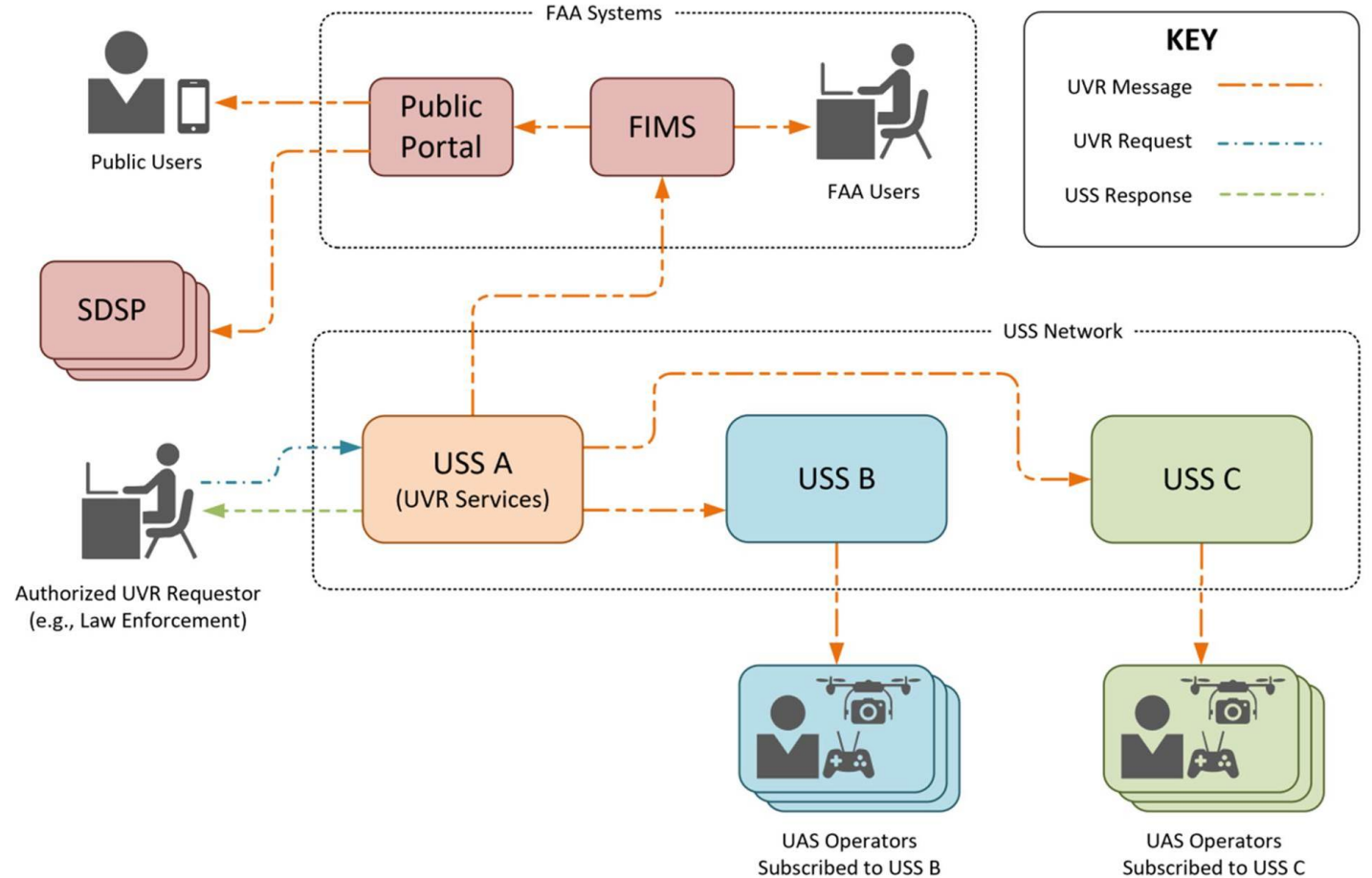
- Environment:
 - High-density airspace in an urban area
 - Controlled airspace
- This use case explores:
 - UVR request, creation, and distribution
 - Coordination between UAS operators within a UVR volume



Use Case 3

Title: Public Safety UAS Operating within a UVR Volume

- Scenario:
 - A fire is occurring at a commercial warehouse and authorized public safety personnel request a UVR from USS A to notify non-critical UAS operating in the area
 - USS A sends a UVR message to impacted USSs, which then notify their own subscriber bases, and connects to FIMS, which then notifies FAA entities
 - Multiple groups operating public safety and support UAS operate within the UVR and strategically deconflict from one another through USS services



Notional Diagram of UVR Request, Creation, Distribution

Complies with applicable privacy rules and policies

Use Case 4

Title: Public Identification of UAS via Remote ID Services

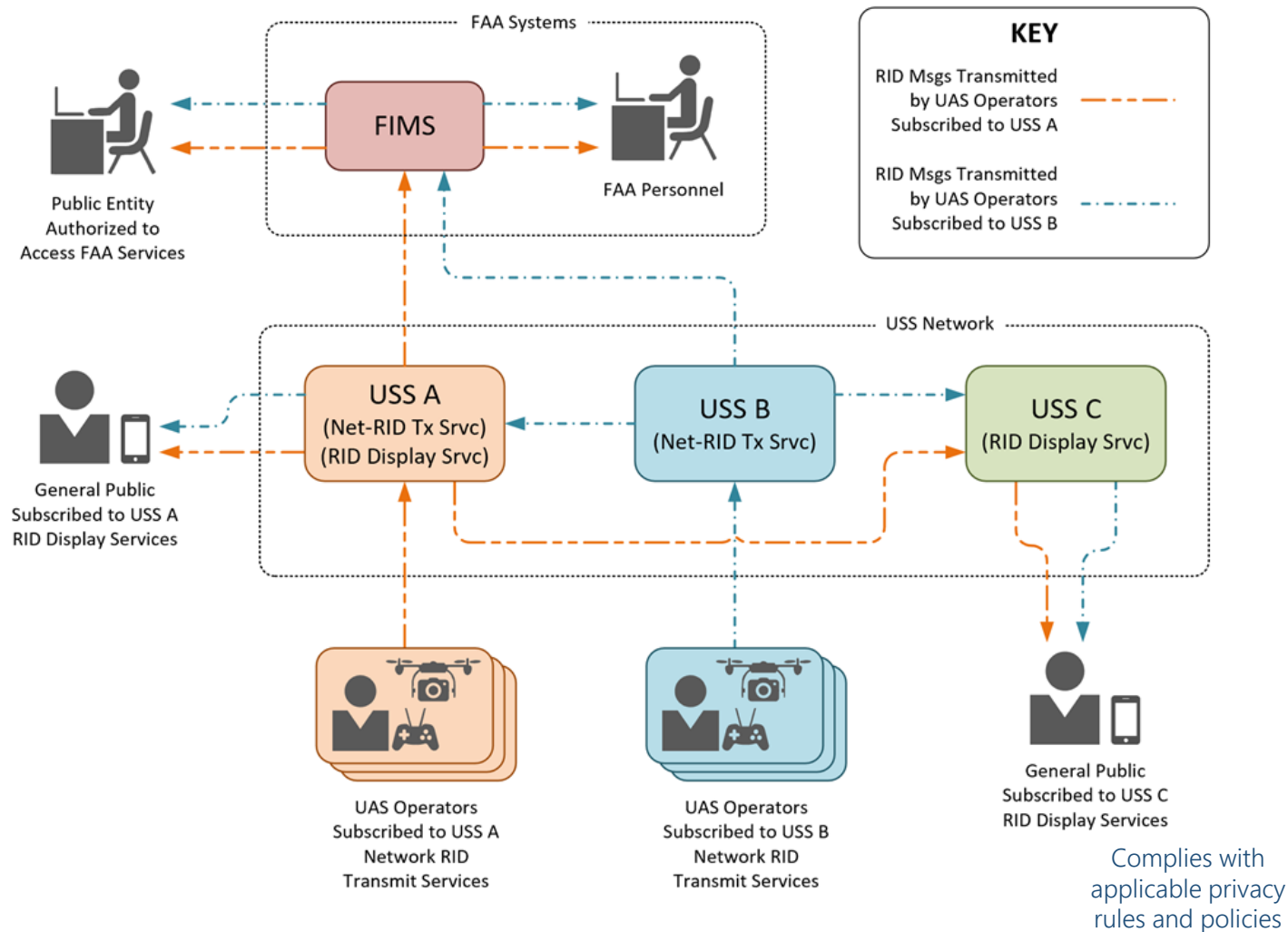
- Environment:
 - High-density airspace
 - Controlled airspace
- This use case explores:
 - RID message exchanges between USSs via the USS Network
 - Authorized public safety query to FAA for RID messages
 - FAA queries to USSs for RID Messages
 - Public query to network RID display USS for RID messages



Use Case 4

Title: Public Identification of UAS via Remote ID Services

- Scenario:
 - After noticing a UA flying over their property, a citizen initiates a RID message query to a USS which then uses discovery services to identify active USSs providing network RID transmission services that are relevant to the query
 - A public safety entity is authorized to use FAA RID display services and after being authenticated by FAA systems, initiates a RID message query to FIMS



Notional Diagram of Public Request to Network RID Display for RID Messages

Use Case 5

Title: Federal and Public Safety Queries for Historical UTM Information

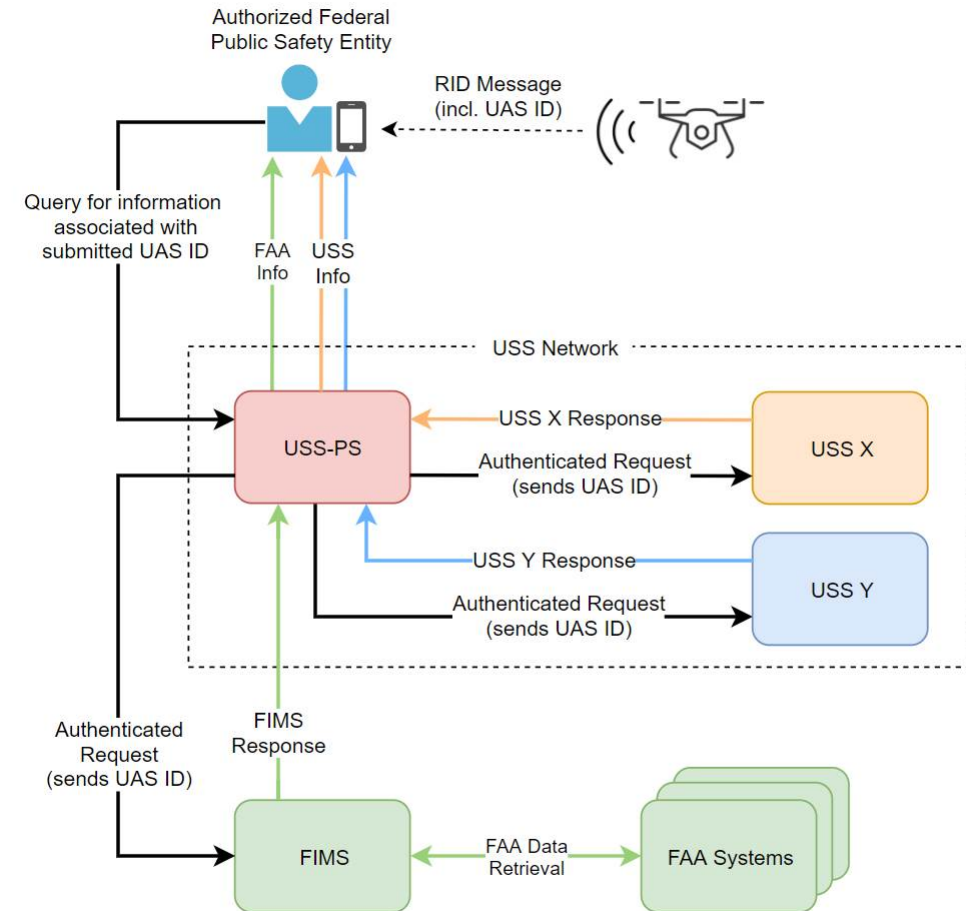
- Environment:
 - High-density airspace
- This use case explores:
 - Authorized Public Safety query for FAA-held data associated with UAS ID
 - FAA request for USS-held data associated with UAS ID



Use Case 5

Title: Federal and Public Safety Queries for Historical UTM Information

- Scenario:
 - A TFR has been created for a major sporting event and public safety personnel are monitoring the area for UAS not permitted to be within it
 - For a UA whose UAS ID does not match a known or authorized vehicle, the USS-PS can support authorized requests for historical information that is not publicly available, either directly to the associated USSs or indirectly via FIMS



Notional Diagram of Authorized Public Safety Query for USS-Held Data Associated with UAS ID

Complies with applicable privacy rules and policies

Next Steps



Next Steps

Provide feedback on today's discussion by December 20, 2019 to FAAUTM@FAA.gov

FAA UAS Test Sites

- SIR release scheduled for December 2019
- Form partnerships with industry and IPP Participants to meet required functionality

USSs, UAS Operators, UAS IPP Participants, and Industry

- Interested parties should work with the FAA UAS Test Sites to form proposal teams for UPP 2

